RHIC BBLR design and new long-range beam-beam measurement

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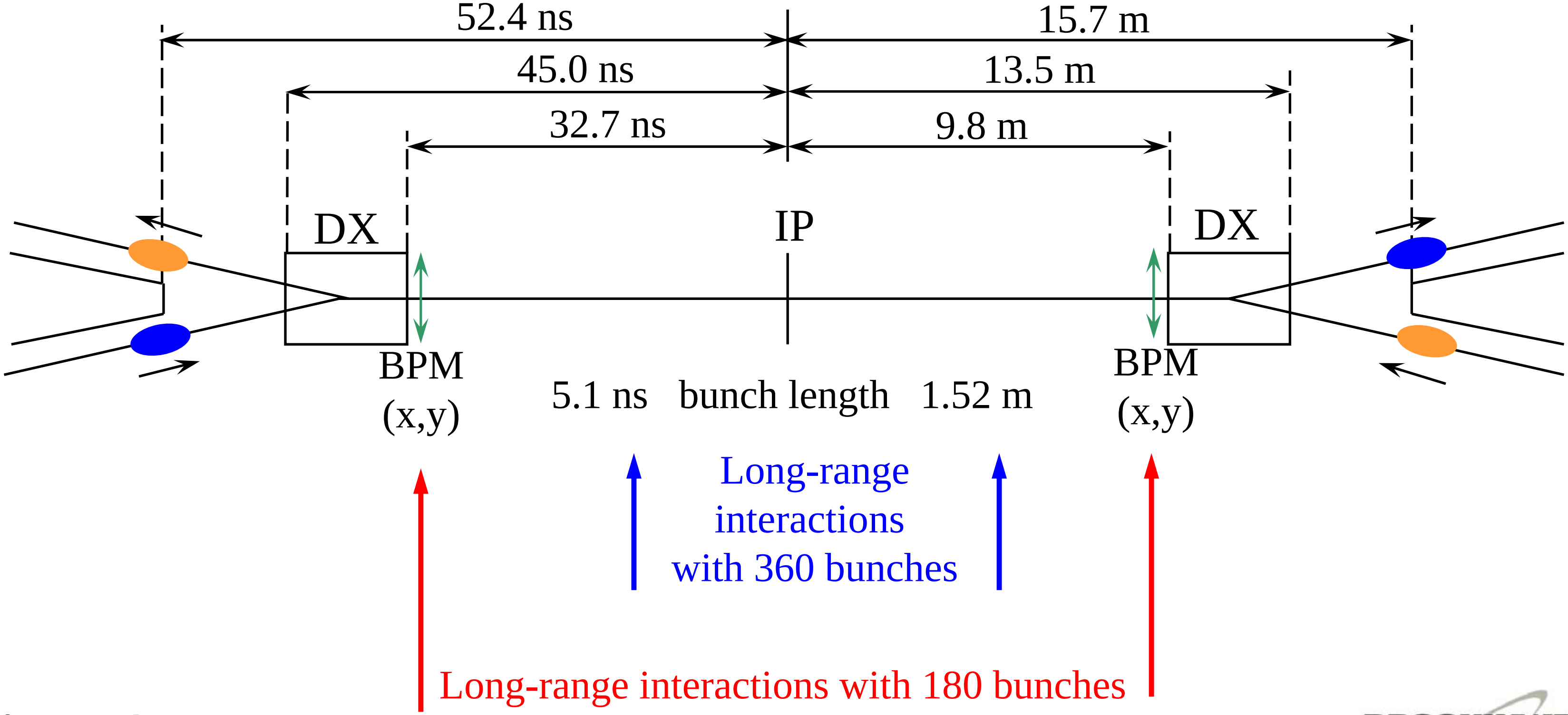
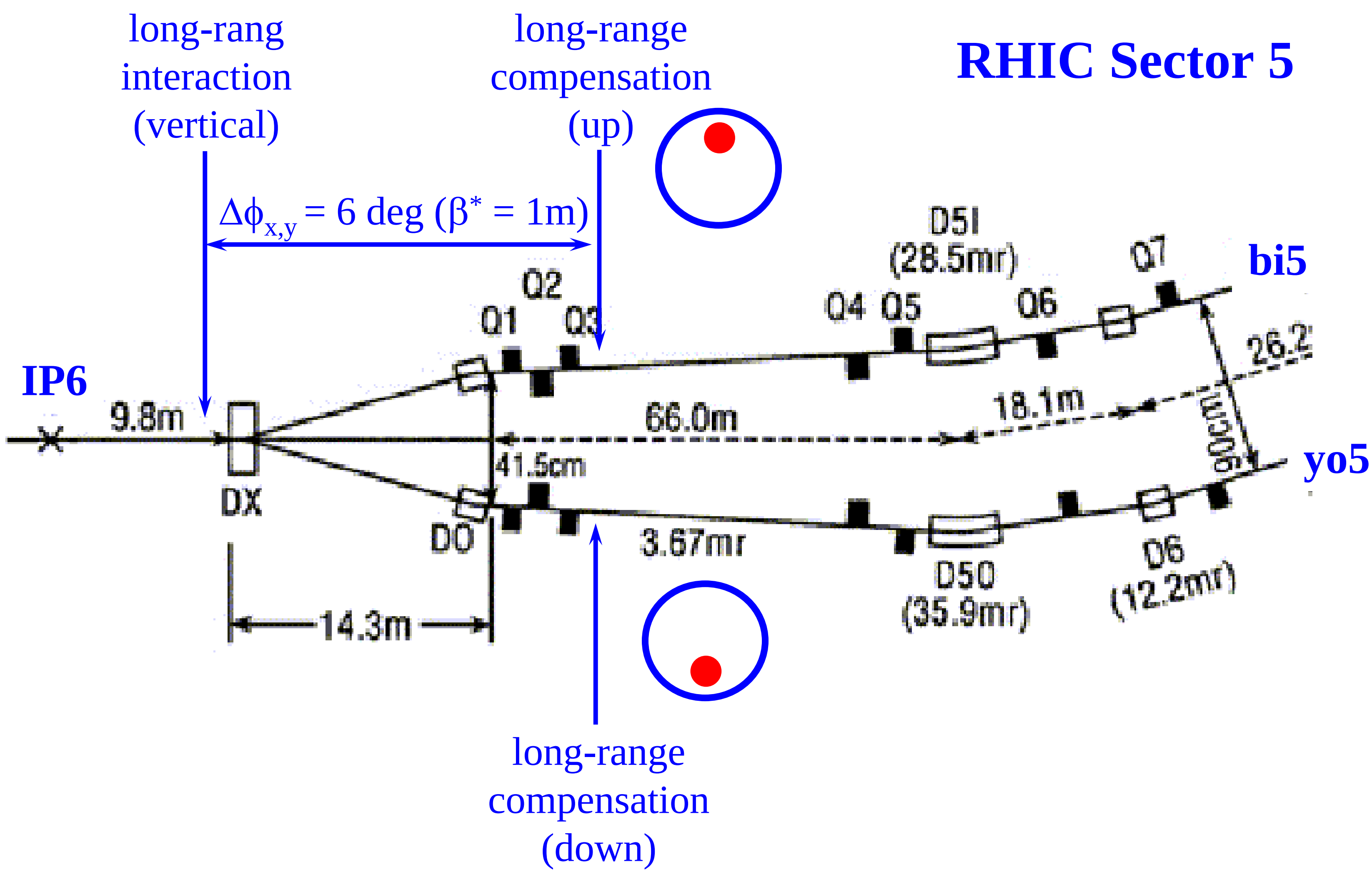
RHIC Interaction Region

- LRBB important effect in LHC (and B-factories), under investigation in LARP
- Partial compensation recently successful in DAΦNE (τ_ℓ improved)
- With >120 bunches cannot avoid long-range beam-beam interactions (eRHIC)
- RHIC is a good test bed for a wire compensator (more difficult in Tevatron)



RHIC BBLR design – locations

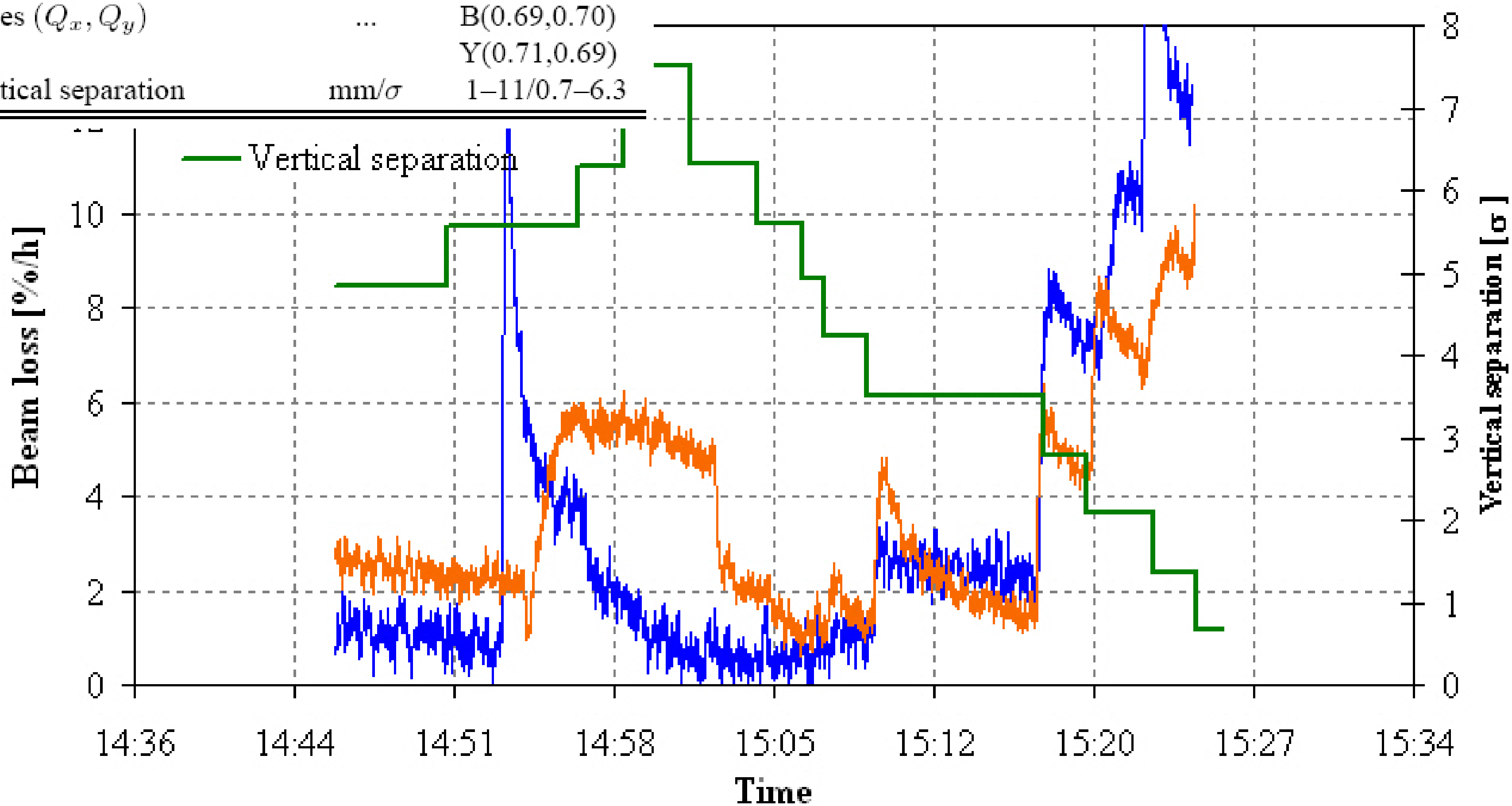


Long-range beam-beam effect at 100 GeV

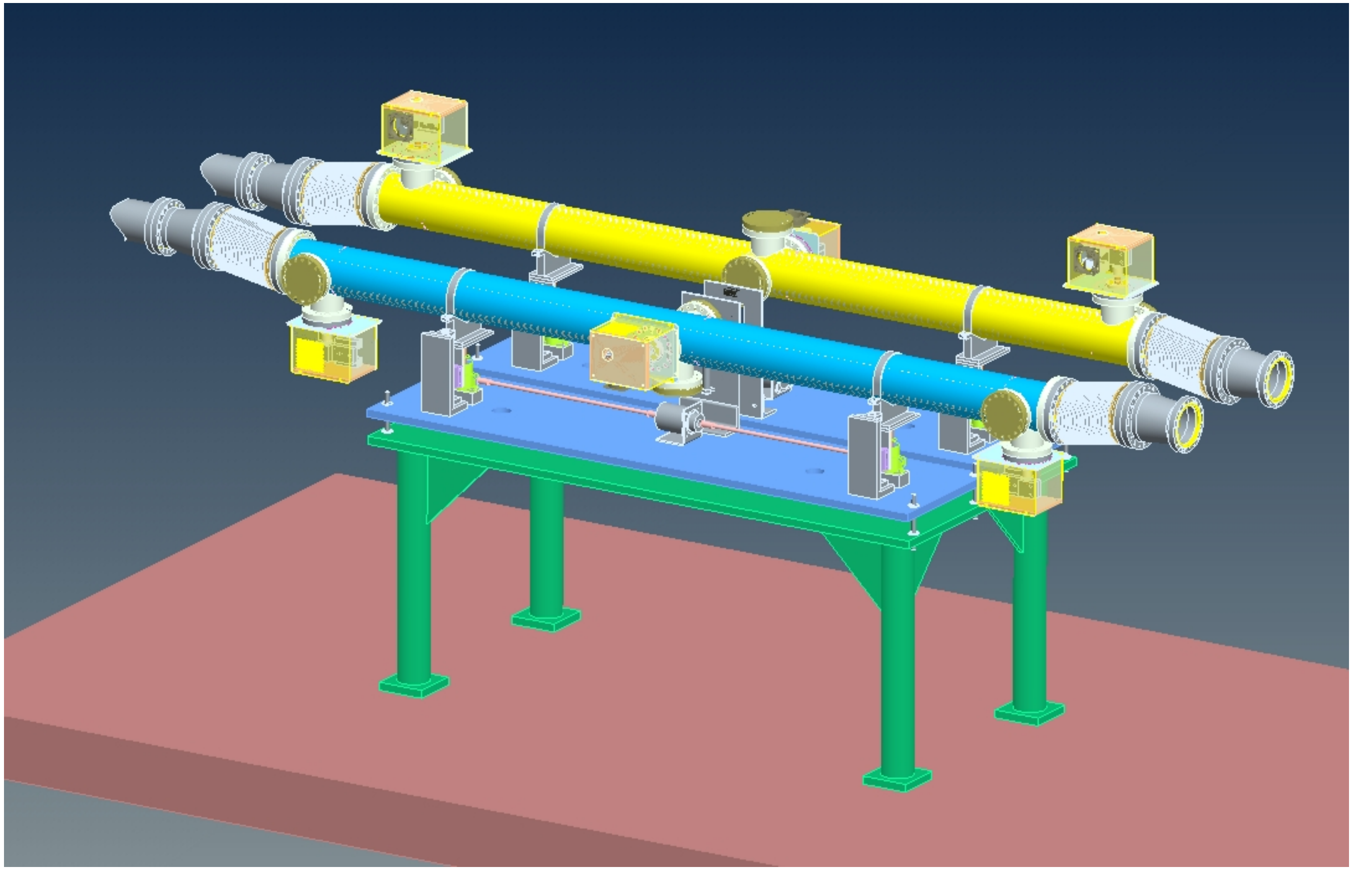
Table 1: Main parameters for the RHIC test at 100GeV.

quantity	unit	value
proton energy	GeV	100.0
bunches per beam	...	12
bunch intensity	10^{11}	1.7
long-range location	m from IP	10.6
emittances $\epsilon_{x,y}$ (95%)	mm mrad	10-15
$\beta_{x,y}$, long-range location	m	105
tunes (Q_x, Q_y)	...	B(0.69,0.70)
		Y(0.71,0.69)
vertical separation	mm/σ	1–11/0.7–6.3

- LR at s=10.6m
- Octupoles on in Yellow
- Blue beam moved



RHIC long-range beam-beam compensator design



- 1 unit in each ring, side-by-side
- vertically movable

  (wire in shadow of adjacent beam pipe when not in use)

RHIC long-range beam-beam compensator design

Table 3: Main parameters for RHIC long-range beam-beam compensators.

quantity	unit	value	comment
integrated strength (IL), single interaction	Am	9.6	
maximum integrated strength $(IL)_{max}$	Am	125	
length of wire L	m	2.5	
radius of wire r	mm	3.5	
number of heat sinks n	...	3	at both ends and in middle
electrical resistivity ρ_e	Ωm	1.72×10^{-8}	Cu (at 20°C)
heat conductivity λ	$\mathrm{Wm^{-1}K^{-1}}$	384	Cu (at 20°C)
density ρ_g	$\mathrm{kg/m^3}$	8.96×10^3	Cu (at 20°C)
thermal expansion coefficient	$\mathrm{K^{-1}}$	1.68×10^{-5}	Cu (0 to 100°C)
melting temperature	K	1083	Cu
radius of existing beam pipe r_p	mm	60	
current in wire I, single interaction	A	3.8	
maximum current in wire I_{max}	A	50	
electric resistance R	mΩ	1.12	
maximum voltage U_{max}	mV	55.9	
maximum dissipated power P_{max}	W	2.8	
maximum temperature change ΔT_{max}	K	15	
maximum change in length ΔL_{max}	mm	0.4	
vertical position range	mm	65	
vertical position range	σ_y	10.6	for $\gamma = 107$, $\beta^* = 1$ m, and $\epsilon_n = 20$ mm·mrad
weight of wire G	kg	0.9	

Summary

- Long-range beam-beam effect observable at 100 GeV (not very pronounced)
- Plan to install long-range compensator in summer 2006 (still under construction)
- Planned tests in Run-7:
  - Single beam and compensator
    (enhanced diffusion may help compensation)
  - Long-range beam-beam and compensator